Structure and function of PBL scenarios in environmental science education

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Abstract

In problem based learning, scenarios connecting to real life are used as a point of departure for the learning process. Even though the importance of well-designed cases or scenarios to bring about a fruitful learning process is emphasised in the literature, few studies focus on how they actually function in the learning process. This study focuses on how the scenarios used in a ten-week introductory course of a new PBL programme in environmental science functioned in terms of the structure and content of the questions they evoked. Data was gathered through diary notes from nine groups of students, comprising 5-8 students per group. The data was subjected to a qualitative analysis aiming at describing the structure and content of the questions generated by the groups to direct the learning process. Five different kinds of questions were identified and labelled; A. Encyclopaedic, B. Meaning-oriented, C. Relational, D. Value-oriented and E. Solution-oriented. All scenarios generated questions pertaining to all five categories in all groups, but the emphasis varied. The results are discussed in relation to the design of scenarios, and in relation to students" approaches to learning.

Introduction

One of the key features of problem based learning is the use of scenarios connecting to real life as a point of departure for the learning process. The design of these scenarios varies to a large extent and they are referred to in the literature as for example problems, cases, and vignettes or, as here, scenarios. Working with scenarios is considered to provide a meaningful context for the concepts and principles that also relate to the coming professional work. The ini-

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tial phase of the learning process consists of at least three different parts. The students are assumed to learn how to identify their knowledge in relation to a problem, to identify their learning needs and to identify how to best acquire the relevant learning. Standard texts on problem-based learning emphasise the importance of well-designed cases or scenarios to bring about a fruitful learning process (Kjellgren, et al. 1993; Boud & Feletti, 1991).

What are then the characteristics of a well-designed scenario for problem-based learning, and what role does it play in the learning process? Few researchers have focused on these issues but one example is Dolmans and colleagues (1997) who have put forward seven principles of effective scenario design for problem based curricula. In short, they claim that scenarios should connect to the students" knowledge and experiences. Furthermore, they emphasise that scenarios should be complex but not overloaded or too structured. They should also relate to the forthcoming profession, encouraged self-directed learning and present relevant basic science concepts. Furthermore, a scenario should enhance students' interest in the subject matter and match one or more of the faculty objectives. These authors do not problematise various conceptions of PBL and the examples all originate from medical curricula. It is therefore possible that the outlined principles might not be valid for scenarios in environmental science since the field of knowledge is of a different nature. In environmental science, different actors have different disciplinary perspectives that lead to different definitions of the problems. These different definitions themselves pose a problem for environmental science and the management of environmental problems. The overall objective for education in environmental science and consequently, the structure of learning appropriate is thus that students should develop an ability to discern different perspectives.

Most studies aiming at evaluating what makes up an effective scenario have focused on the relationship between student-generated learning issues and faculty objectives (for an overview see Dolmans et al 1993, 1994). However, even though several texts emphasise the importance of well-designed scenarios, few studies focus on how scenarios actually work during the learning process. In order to evaluate how scenarios function it is necessary to describe the structure as well as the content of the questions evoked and their relevance in relation to the aims of the course. It is also important to assess more fully the use of scenarios and develop a deeper understanding of the effects of variations in use.

In August 1998, a new four-year problem based undergraduate programme in environmental science was initiated at Linköping University, Sweden. The programme focuses on the complexity of environmental

issues and the need for environmental scientists to be able to evaluate scientific and technical issues in relation to their social and cultural context. Throughout the programme students are presented with various scenarios that are used as points of departure. The scenarios used are a mix of authentic environmental cases, constructed environmental cases, images or texts that are indirectly linked to authentic or constructed environmental cases, as for example, comic strips, photographs, paintings, and newspaper headings or articles.

The aim of the study

The aim of the present study is to describe how scenarios used in environmental science education function in terms of the type of questions they evoke. The study is based on written notes and reports focussing on the learning process made by nine groups of students during a course. The course chosen is the ten-week introductory course at the environmental science programme at Linköping University (http://bomull.ituf.liu.se/miljo). The results of the study will be presented and discussed in more depth in a paper (Abrandt Dahlgren & Öberg, forthcoming).

Materials and method

The ten-week introductory course was called "What is an environmental problem?" The objectives of the course were formulated as the intended learning outcome and given to the students at the start as a guide for their learning. The overall aim was that the students should deepen their understanding of the complexity of environmental problems and start to discuss and problematise environmental issues. The students were also expected to become able to problematise the following concepts: anthropogenic/natural, nature/culture, global/local, urban/rural, developed/developing countries, east/west and past/present/future. In addition, the students were to become acquainted with the pedagogic model used in the programme.

The empirical data for the present study are the notes from the nine groups as well as the reports focusing on the learning process. The data was subjected to a qualitative analysis aiming at describing the structure and content of the questions generated by the groups to direct the learning process. The categories were generated through the analysis and not defined in advance.

All comments quoted below were translated from Swedish to English by the authors.

The design of the scenarios

Five scenarios were used as a point of departure for the learning process. The first one, a comic strips from the cartoon "Assar" drawn by the Swedish artist Ulf Lundkvist and was used to introduce the whole course (Dagens Nyheter 12 april 1998). The comic strip consists of two drawings. On the first drawing, a man is standing behind a box of fish with a sign reading ecological fish and a woman asks what does this mean? On the second drawing, the man answers: They all died a natural death. The second scenario was a front page from a brochure that is published as report by the Swedish environmental protection agency, dealing with protected arable land (Naturvårdsverket, 1997). The cover depicted a typically Swedish pastoral idyll showing a red cottage in a fenced meadow with a small gate. The heading ran across the picture and the logotype of the agency was placed in the upper left corner. This scenario aimed to stimulate discussions in relation to the concepts natural/anthropogenic and nature/culture. The third scenario was a pencil drawing, aiming at highlighting the concepts global/local and urban/rural. The drawing portrayed a van meeting a bus full with passengers on a country road. The van has a picture of a cow on the side with the word Milk running above. The fourth was the front page of a magazine (EcoForum, 1997), aiming at relating to the concepts developed/developing countries and east/west. The cover pictured a big hand coming out of a cloudy sky pointing a huge finger on a huge note that in front of a number of people that obviously come from different parts of the world. The text on the note is illegible but the words Agenda 21 can be deciphered. The scenarios two to four was used for two weeks each. The fifth was used for three weeks, and was an old saying; Those were the days, that was typed on a piece of paper and aimed at relating to the concepts past/present/future.

Results

Our analysis generated the following five categories of questions:

A. Encyclopaedic questions

The encyclopaedic questions are formulated in a way that suggests that the students expect to find an unambiguous and not too complex answer. Typically, the lexical meaning or criteria to define a certain term or phenomenon is asked for. Terms that are used in the objectives of the course or found in the scenarios are sometimes the topic. The questions pertaining to this category are characterised by a kind of one-dimensionality, in the sense that they contain only one aspect that is to be defined, which

often is quantitative (e.g. how many, how long, when). The meaning of the term or phenomenon in a deeper sense is not asked for. In some cases, the questions are formulated such that they may be answered with a "yes" or "no". The phrasing is also typically characterised by the use of question words like "who", "what", "which", "where". Examples of this type of questions are:

Are environmental problems complex and global?
(Group 8, scenario 1)

How long has the environmental protection agency existed?
(Group 1, scenario 2)

B. Meaning-oriented questions

In this category the questions are typically oriented to find the phenomenological meaning of certain terms or concepts. The context reveals that the students do not expect to find a direct answer in for example an encyclopaedia or dictionary. The terms in focus are often defined or problematised in relation to other terms. Typical question words used in this category are: what is the meaning of; what is; why.

What does a natural death mean?
(Group 8, scenario 1)

Is there anything that is natural?
(Group 3, scenario 2)

C. Relational questions

The relational questions contain more than one aspect and the relationship between these. Typically, they aim at explaining causes or understanding consequences of a certain phenomenon. Causal as well as general relationships are emphasised. The questions deal with rather complex contexts with multiple dimensions. Typical nouns included in the questions are "influence", "effect", and "consequence". The following excerpts exemplify this category;

What is the effect of urbanisation?
(Group 8, scenario 3)

What influence does the cultural landscape have on the biological diversity?
(Group 2, scenario 2)

D. Value-oriented questions

The value-oriented questions are comparative in nature. They aim to evaluate environmental consequences in terms of better or worse. The searching of norms for judgement is a central feature although it is clear that the students do not expect to find supreme norms. On the contrary, the ques-

tions give the impression that the students search for answers that will enable them to develop value-based standpoints. These questions sometimes expand outside the learning context of the course, enclosing existential issues. Typical value-oriented words used in the phrasing are "what is good", "what is bad", as exemplified below;

What type of transports are good/bad for the environment?
(Group 8, scenario 3)

What type of energy sources would be best for the future?
(Group 6, scenario 5)

E. Solution-oriented questions

The focus of the solution-oriented questions is the management of environmental issues rather than to search the meaning of varying aspects of these problems. Characteristically, the questions deal with large and complex problems on an abstract level and the students appear to look for concrete solutions. The phrasing contains typical verbs as "do", "diminish", "change", and "distribute". The following questions are typical of this category;

What can we do about the fish problem?
(Group 6, scenario 1)

What can we do to decrease the number of transports?
(Group 8, scenario 3)

Discussion

One of the principles for effective case design put forward by Dolmans and colleagues (1997) is that the scenarios should contain enough but not too many cues to enable students to elaborate their discussions. In our interpretation, this suggests that complexity is an important feature of scenarios. The first (the comic strip), second (the pastoral idyll) and fourth scenarios (the big hand holding a note in front of people from different parts of the world) were rather complex and the students did problematise them in depth in relevance to the course objectives. On the other hand, the third scenario (the bus and the milk van) appeared to contain too few cues to be properly problematised. It made the students focus mainly on transport issues, that was only one of the major objective of the course. This supports the notion of complexity as an important feature of a well-functioning scenario.

However, the fifth scenario (the old saying) comprised only one sentence, thus containing very few cues and this scenario worked as well as the other. This indicates that it is not complexity in itself that constitutes

a fruitful scenario. What did the four scenarios that worked well hold in common? A closer look suggests that scenarios that were provoking or evoked emotional engagement, for instance by containing a certain opinion or some kind of contrast or tension, were powerful triggers. This is well in line with the arguments by Russell (1999), drawing on the writings by Dewey (1933), who claims that perplexity is one of the defining features of reflective thinking and problem engagement. Reflective thinking involves

> ...(1) a state of doubt, hesitation, perplexity, mental difficulty in which thinking originates, and (2) an act of searching, hunting, inquiring, to find materials that will resolve the doubt, settle and dispose of the perplexity (Dewey, 1933, p.12, cited in Russell, 1999)

Russell suggests that the affective state of perplexity in the learner has been overlooked as an important feature of problems in problem based learning. He even argues that problems in PBL often lack this feature. In many cases, the problems serve the purpose of directing the students towards the achievement of knowledge of something specific, rather than "finding its focus on the problem of the problem" (p. 185).

The different kinds of questions generated are different in nature but, nevertheless, provide a picture of the students' approaches to learning. Differences between approaches to learning are, as Bowden and Marton (1998) put it, differences in what the learners are focusing on, what they are trying to achieve and how they are going about it.

> When adopting a surface-approach to learning, the learners are focusing on surface characteristics of the situation, on the very wording of a text being read, of the argument put forward, on figures in a problem, on formulas to be used for solving the problem. /.../ When adopting a deep approach to learning, the learners are focusing on the object of learning, they are trying to get hold of the phenomenon dealt with in the text they are reading or in the presentation they are listening to. In problem solving they are initially trying to grasp the problem (p.8)

The encyclopaedic questions could indicate that the students use a surface-approach, looking mainly for the lexical meaning of a word or a concept. On the other hand, even though the encyclopaedic questions were relatively large in number, none of the groups asked this type of questions as their only way of working through any of the scenarios. Instead, the typical pattern was a dynamic process, moving back and forth between encyclopaedic questions and meaning-oriented or relational questions, searching for understanding and explanation, thus, indicating a deep-approach. It can be assumed that all four types of questions described here are necessary to bring about a meaningful learning. The scenarios seem to generate

a context in which encyclopaedic questions naturally get linked to meaning-oriented and relational questions.

We have here focused mainly on the process of working through the scenarios and our findings may shed some light on the approaches to learning adopted. The influence of the different kind of questions asked on the outcome of learning is an issue that needs to be further explored in forthcoming studies.

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